Bureau of Standards
JAN 21 1926

DEPARTMENT OF COMMERCE

TECHNICAL NEWS BULLETIN

OF THE BUREAU OF STANDARDS

Subscription, 25 cents a year. Address "Superintendent of Documents, Washington, D. C."

Washington, January, 1926. No. 105

STANDARD RADIO-FREQUENCY TRANSMISSIONS, JANUARY TO MARCH

The Bureau of Standards transmits, twice a month, radio signals of definitely announced frequencies, for use by the public in standardizing frequency meters (wave meters) and transmitting and receiving apparatus. The signals are transmitted from the bureau station WWV, Washington, D. C., and from station 6XBM, Stanford University, Calif.

The transmissions are by unmodulated continuous-wave radio telegraphy. A complete frequency transmission includes a "general call," a "standard frequency signal," and "announcements." The "general call" is given at the beginning of the eight-minute period and continues for about two minutes. This includes a statement of the frequency. The "standard frequency signal" is a series of very long dashes with the call letters (WWV or 6XBM) intervening. This signal continues for about four minutes. The "announcements" are on the same frequency as the "standard frequency signal" just transmitted and contain a statement of the frequency. An announcement of the next frequency to be transmitted is then given. There is then a four-minute interval while the transmitting set is adjusted for the next frequency.

The signals can be heard and utilized by stations equipped for continuous-wave reception at distances within about 500 to 1,000 miles from the transmitting stations. Information on how to receive and utilize the signals is given in Bureau of Standards Letter Circular No. 171, which may be obtained on application from the Bureau of Standards, Washington, D. C. Even though only a few points are received, persons can obtain as complete a wave-meter calibration as desired by the method of generator harmonics, information on which is given in the letter circular.

The schedule of standard frequency signals from both the Bureau of Standards and Stanford University, during the next three months, is as follows:

Schedule of frequencies in kilocycles

[Approximate wave lengths in meters in parenthesis]

Time (p. m.)[1]	Jan. 5	Jan. 20	Feb. 5	Feb. 20	Mar. 5	Mar. 20	Time (p. m.)[1]	Jan. 5	Jan. 20	Feb. 5	Feb. 20	Mar. 5	Mar. 20
10 to 10.08	1,500 (200)	3,000 (100)	125 (2,400)	300 (1,000)	550 (545)	1,500 (200)	10.48 to 10.56	2,200 (136)	4,400 (68)	166.5 (1,800)	425 (705)	980 (306)	2,200 (136)
10.12 to 10.20	1,650 (182)	3,300 (91)	133 (2,254)	315 (952)	630 (476)	1,650 (182)	11 to 11.08	2,450 (122)	4,900 (61)	205 (1,463)	500 (600)	1,130 (265)	2,450 (122)
10.24 to 10.32	1,800 (167)	3,600 (83)	143 (2,097)	345 (869)	730 (411)	1,800 (167)	11.12 to 11.20	2,700 (111)	5,400 (55)	260 (1,153)	600 (500)	1,300 (231)	2,700 (111)
10.36 to 10.44	2,000 (150)	4,000 (75)	155 (1,934)	375 (800)	850 (353)	2,000 (150)	11.24 to 11.32	3,000 (100)	6,000 (50)	315 (932)	666 (450)	1,500 (200)	3,000 (100)

[1] Eastern standard time for WWV, Washington, D. C.; Pacific standard time for 6XBM, California.

STANDARD FREQUENCY STATIONS

As a result of measurements by the bureau upon the transmitted waves of a limited number of radio transmitting stations, data are given each month on such of these stations as have been found to maintain a sufficiently constant frequency to be useful as frequency standards. There may be many other stations maintaining their frequency just as constant as these, but these are the only ones among those observed. There is, of course, no actual guaranty that the stations named below will maintain the constancy shown, but the data indicate the high degree of confidence that can be placed in them. The transmitted frequencies from these stations can be utilized for standardizing frequency meters and other apparatus by the procedure given in Bureau of Standards Letter Circular No. 171, which may be obtained by a person having actual use for it upon application to the Bureau of Standards, Department of Commerce, Washington, D. C.

Station	Owner and location	Assigned frequency (kilocycles)	Period covered by measurements	Number of times measured	Deviations from assigned frequencies noted in measurements	
					Average	Greatest since Nov. 20, 1925
			Months		*P. ct.*	*P. ct.*
WQL	Radio Corporation of America, Coram Hill, Long Island, N. Y.	17.13	12	79	0.2	0.1
NSS	United States Navy, Annapolis, Md.	17.50	28	207	.2	.1
WCI	Radio Corporation of America, Barnegat, N. J.	17.95	10	57	.2	.2
WGG	Radio Corporation of America, Tuckerton, No. 1, N. J.	18.86	28	217	.2	.2
WII	Radio Corporation of America, New Brunswick, N. J.	21.80	8	69	.1	.2
WRT	Do	22.60	7	24	.1	.1
WVA	United States Army, Annapolis, Md.	100	9	101	.2	.4
NAA	United States Army, Arlington, Va.	[1] 113	2	18	.1	.3
WJR	Jewett Radio & Phonograph Co., Pontiac, Mich.	[2] 580	3	15	.0	.0
WCX	Detroit Free Press, Detroit, Mich.					
WEAF	American Telephone & Telegraph Co., New York, N. Y.	610	12	87	.0	.0
WCAP	Chesapeake & Potomac Telephone Co., Washington, D. C.	640	27	120	.1	.2
WRC	Radio Corporation of America, Washington, D. C.	640	24	107	.1	.2
WSB	Atlanta Journal, Atlanta, Ga.	700	27	129	.2	.3
WGY	General Electric Co., Schenectady, N. Y.	790	30	151	.1	.0
WBZ	Westinghouse Electric & Manufacturing Co., Springfield, Mass.	900	20	66	.1	.2
KDKA	Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.	970	27	193	.1	.4

[1] Time signal frequency.
[2] Same transmitting set for both call letters (WJR and WCX).

THE DISTANCE RANGE OF RADIO-TELEPHONE BROADCASTING STATIONS

As is well known, the conditions affecting radio transmission are too complex to permit a simple analysis. A direct method of studying such conditions and their variations is the analysis of a large number of similar observations taken by an organized group of observers of receiving conditions. The bureau has made such an investigation, and part of the results are described in a paper just issued, Technologic Paper No. 297, A Statistical Study of Conditions Affecting the Distance Range of Radio Telephone Broadcasting Stations, by C. M. Jansky, jr. This paper describes one year's work on the investigation of conditions affecting distance range of broadcasting stations by the Bureau of Standards with the aid of about 100 voluntary observers. The observations were made for a year in the period 1922–23 on transmitting station KDKA of the Westinghouse Electric &

Manufacturing Co., East Pittsburgh, Pa. The observers were scattered over all distances up to 400 miles from the transmitting station. The data obtained were analyzed on automatic machines. The paper gives charts showing (1) variation of strength of atmospherics, (2) variation of fading, (3) relative magnitude of obstacles to reception, (4) variation of interference from receiving sets, (5) relative magnitude of obstacles to reception grouped in bimonthly periods, and (6) mean reliability of reception as a function of distance. A copy of this paper may be obtained for 5 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

DENTAL RESEARCH

Excellent progress is being made in the program of dental research which is being conducted at this bureau through the cooperative research fellowships supported by the Weinstein Laboratories of New York.

Representative alloy golds, used for dental restorations, have been tested in their natural conditions as received from the dental sales depots. Further tests on these golds after casting or forming have shown in many instances serious defects. A number of these can be attributed to the manipulative procedures now common among the profession.

The occasions for these defects and misfits can be any one or more of the stages through which the inlay technic is carried. An outline of these stages, together with the more obvious faults possible, will make clear the problems before the bureau's laboratory.

Restorations are usually made by the substitution process wherein a wax pattern, which has been molded or carved to restore the lost portions of the tooth, is reproduced by the cast gold alloy.

Defects result from: (1) Improper adaption of the wax to the cavity. (2) Distortions of the wax during or after removal from the cavity. These may result from pressures applied or from a release of stresses by heating. There appears to be a sort of "memory" quality to the waxes used, which causes them to undo the last movement given in forming them into the desired shape. This tendency becomes serious at temperatures above room temperatures. (3) Defects in the investing material. Investment mixes often contain air or other foreign material. These appear later as voids in the set investment which supports the wax pattern and which becomes the crucible into which the molten gold will be forced. When the gold fills these voids, the casting is not a reproduction of the wax and hence does not fit the tooth cavity. These voids are being eliminated by a vacuum method and by a mixing technic which will be described more fully in a later publication.

There are no less than seven sources of these defects. The above are, however, sufficient to show the complications and unexpected causes of failures which are being studied and eliminated in the research. The value of such work is evident to any one seeking good dental work.

FLOTATION OF ENAMELS

Since the preceding item on this subject in the Technical News Bulletin (No. 101, September, 1925), experiments have been performed, in which the consistency of ground coat enamel slips has been studied.

Consistency is measured by observing the rate of flow of the slips through a capillary tube at known pressures and at a constant temperature (modified Bingham apparatus). This test furnishes data for determining the yield value which is a measure of the ability of an enamel to adhere when applied wet to a metal base.

Aging produced a decrease in yield value by an amount approximately proportional to the time of aging. In order to determine whether or not this change in properties with aging is caused by continued solution from the ground enamel, samples were made up which differed from each other only in concentration of materials dissolved. Tests showed that the solutions of higher con-

centration produced a decreased yield value, thus indicating that solution from the frit (ground enamel) is an important source of the change in consistency which accompanies aging. Further experiments indicated that materials dissolved from the frit, considered as a whole, tend to deflocculate the finer particles of enamel. The inference is that an agent which increases deflocculation produces decrease in yield value.

IMPROVED SECONDS SIGNAL

Considerable attention has recently been devoted by the time section of the bureau to the problem of securing a seconds signal of high accuracy from a pendulum by means of a photoelectric cell. The main problems considered so far have been the character and intensity of the source of illumination, the type of supply current, the type and numbers of amplifying units and the sensitivity of the transmitting relay. The source which appears to be most successful is a 1,000 lumens street lamp having a short vertical filament of high candle power. By means of a lens a beam of light from this source can be focussed on the cell, giving a vertical line image only a little over one-eighth inch wide. The pendulum in cutting the beam of light results in a very sharp action on the cell. The current from the cell, amplified by means of two radio tubes in parallel, operates a special relay which transmits the signal. A new type of relay has been ordered, and it is expected that this will eliminate the occasional sticking which has occurred with the relay formerly in use. A signal of this type will have important applications in laboratories.

ALTITUDE-PRESSURE TABLES FOR CALIBRATION OF ALTITUDE-INDICATING INSTRUMENTS USED BY AIRCRAFT

The altimeters used for measuring the altitude of aircraft operate on the principle of an aneroid barometer; that is, changes in the pressure of the atmosphere deflect a flexible diaphragm which in turn moves a pointer over a graduated dial. Since altimeters actually measure the pressure of the atmosphere, yet are graduated in terms of altitude, it is necessary to assume an arbitrary relation connecting altitude and pressure. For this reason an arbitrary altitude-temperature-pressure relation known as a standard atmosphere is chosen, representing average atmospheric conditions as closely as is feasible. From this assumption the pressures corresponding to different altitudes are computed and the resulting relation between pressure and altitude is called an altimeter calibration standard when used in this way.

The altimeter calibration standard which has been used up to the present time in the United States assumes that the atmosphere is at a constant temperature of 50° F. at all altitudes. This represents average conditions up to heights of about 12,000 feet accurately, but above 12,000 feet this assumption is not even approximately correct since the temperature of the air decreases rapidly with altitude. For this reason the readings of altimeters calibrated to the old standard are vry inaccurate at the high altitudes at which aircraft now fly quite frequently.

In order to remedy this difficulty, a conference of the Government organizations interested in the problem was held about a year ago, and it was decided to adopt a relation for use in calibrating instruments which was more nearly in accord with the average condition of the atmosphere up to altitudes of at least 50,000 feet. A new altimeter calibration standard was proposed at this conference and has been adopted by the Army Air Service, the Bureau of Aeronautics of the Navy, the National Advisory Committee for Aeronautics, the Weather Bureau, the Bureau of Standards, and the National Aeronautic Association.

The altitude-pressure tables based on this new standard have been prepared by the Bureau of Standards and have been issued as Letter Circular 187, Altitude-Pressure Tables Based on the United States Standard Atmosphere. Copies may be obtained by those having actual use for this material by addressing the aeronautic instruments section of the Bureau of Standards, Washington, D. C.

ACCURACY OF GAS METERS

During the past two years the bureau's attention has several times been called to newspaper statements purporting to have originated at the bureau to the effect that gas meters are the most accurate measuring instruments known. No such statement has ever been made by the bureau, and such articles or paragraphs, therefore, have no foundation in fact. Obviously, no report on this subject can be supplied.

METHODS OF HARDENING HIGH-SPEED ROUGHING TOOLS

Since the discovery some 20 years ago of the benefits derived by subjecting certain chromium-tungsten or so-called high-speed steels to exceedingly high temperatures in hardening, much discussion has centered upon the best procedure and equipment for this heat treatment. There are still those who advocate hardening from a forge fire and claim superior performance for tools so treated in comparison with tools hardened from gas, oil-fired, or electric furnaces.

Some roughing lathe tool tests were recently made at the bureau to determine whether or not such claims were justified. It was found that comparable performance was obtained when tools were raised to approximately equal temperatures for equal times in hardening. The forge-fire method of treatment has certain advantages, but there was no evidence of a mysteriously beneficial effect produced by contact between the tools and carbon of the fuel as have been claimed.

PAPER FOR PERMANENT RECORDS

The degree of permanence of paper is a matter of vital importance. Little is known definitely of the permanence of modern papers, but the numerous requests received by the bureau from departments of the Federal Government, State governments, the Library of Congress, public libraries, and from many business concerns for advice respecting durability of papers indicate that the importance of this property of paper is generally realized. The bureau has conducted some research work on this subject but has not been able to make the intensive study required to obtain definite information on the many different questions involved. In view of the numerous demands for information, however, the following observations may be of interest:

From records of the aging of papers it appears that wood-fiber papers, in general, have given poor service in respect to permanence. Rag-fiber papers, in general, alone have proved suitable for permanent records; but the fact that a paper is made entirely of rag fiber does not in itself ensure permanence. The materials entering into the paper must be chosen with care, so that no materials will be present which in themselves will not be permanent or which will induce deterioration of the paper. It is quite well established that if fibers themselves are to be permanent they must be reduced to as pure a form of cellulose as possible. The purity of the fibers is commonly measured by determining the copper number. As rosin sizing induces decomposition of paper fibers it should not be used. Judging from past records and from results of accelerated aging tests, the sizing should consist of glue only, as when properly applied such sizing is very permanent and has no injurious effect upon the paper fiber. Starch sizing appears to be of doubtful permanence. Chemical residues, especially those of an acid nature, are very harmful. Alum is an acid salt commonly used in paper sizing, and care must be taken that residues of this material in the paper are kept at a minimum. Other chemical residues, such as those derived from the cooking and bleaching operations, should also be reduced as much as possible. In employing coloring materials, only those of established permanency should be used, and only those which will not react chemically with other constituents of the paper.

The need for more definite information is keenly realized and it is hoped that further research may be carried out.

PENCIL AND INK ERASERS

The bureau was recently called upon to determine the comparative erasing properties of different types of pencil and ink erasers with a view to devising, if possible, simple and accurate tests for measuring these properties. While the experiments did not result in the development of any mechanical device which it was thought would prove entirely suitable for testing erasers, some very interesting and practical information on the action of erasers was secured.

Tests were made using three types of paper; a high-grade ledger paper, and two poorer grades of paper such as are often used for pencil papers—one a soft absorbent paper and the other a hard paper with a glazed surface.

In making actual erasing tests it was obvious that all the papers did not behave in the same manner under the action of the eraser, and also that the best eraser for one paper was not necessarily the best for another type of paper.

While in erasing, a person naturally governs the pressure exerted on the eraser and the speed with which the eraser is moved over the paper by the results obtained, so that almost any eraser can be used, it was obvious that for the poorer grades of paper the soft type of eraser is far superior to the hard one. On a high grade, firm paper the hard eraser is to be preferred, as it works faster and can be held to a sharper bevel than a soft one.

Of the several types of erasers made by most manufacturers, the bureau believes that the superiority of one type over another for different kinds of work is not generally understood.

THE DECAY OF STONEWORK IN BUILDINGS

Recent experiments at the bureau have indicated that practically any water-soluble salt, when allowed to penetrate stone and crystallize within the pores, causes a wedging action capable of disrupting the strongest materials. The crumbling and spalling of masonry where exposed to the weather is usually attributed to the action of frost. However, a similar decay has been found inside of buildings or in warm climates where freezing seldom occurs. A study of the conditions surrounding several cases of this kind has been made by the bureau, and has led to the belief that the decay is sometimes caused by a crystallizing of water-soluble matter which is carried into the stone by means of water as it slowly trickles through the pores.

Practically all types of stone as well as brick, concrete, etc., contain small amounts of soluble matter which can be leached out by water. When this matter is concentrated at the surface, it frequently manifests itself as a growth of white crystals and is called efflorescence. Crystals forming within the materials exert a strong wedging action, which often results in spalling the surface, and conditions frequently arise which submit building materials of this type to such action.

THE EFFECT OF IMPURITIES AND THE PROCESS OF MANUFACTURE ON THE PROPERTIES OF CALCINED GYPSUM

In reviewing the literature on the process of manufacture of calcined gypsum it is found that while the various steps used in its manufacture have been studied in detail from a mechanical standpoint, little effort has been made to correlate the variations in the product with the different methods used and the impurities which sometimes naturally occur. With this in mind a study has been made at the bureau of the effect of the fineness of the gypsum, the temperature of calcination, and the effect of some materials in the raw gypsum on the properties of the calcined product. Three different sizes of materials were calcined to four different temperatures, while one size was calcined with seven different impurities, and the properties of the products studied. The properties investigated were composition, tensile strength, fineness, time of set, and plasticity. As only two of the impurities that were used gave deleterious results in the amounts employed, the percentage of each was decreased until the resulting product was approximately the same as

the one in which no impurity was present.

In view of the results obtained, the following conclusions seem to be justified:

1. Raw gypsum passing a No. 100 and retained on a No. 200 sieve calcines more readily than does coarser or finer gypsum.

2. In general, the tensile strength of 1:3 gypsum-sand mixes is increased with increase of the time and temperature of calcination of the gypsum and fineness of the calcined gypsum.

3. The plasticity of 1:3 gypsum-sanded mixes is increased by increased fineness of the gypsum, and by increased semihydrate content, and is decreased by the presence of artificial anhydrite.

4. The time of set of calcined gypsum is lengthened by an increase in the degree of calcination.

5. Of the various impurities studied only sodium chloride and sodium sulphate are deleterious when present in the raw gypsum, although silica does lower the tensile strength.

6. The sodium chloride content of gypsum should be less than 0.15 per cent in order to escape deleterious effects on the properties studied.

7. The sodium sulphate content of gypsum should be less than 0.5 per cent in order to escape deleterious effects on the properties studied.

8. The impurities studied all lower the plasticity of 1:3 gypsum-sand mixes.

9. Sodium chloride when present in raw gypsum seems to convert the gypsum during calcination, into an anhydrous sulphate, which does not appear to revert to the dihydrate on the addition of water.

THERMOCOUPLE PROTECTION TUBES FOR GLASS-MELTING FURNACES

The remarkable advance which has been made in recent years in the quality of commercial glass is attributable largely to better facilities for temperature measurements, and consequently for control of operation. In industrial furnaces the platinum-platinum rhodium thermocouples can be incased in a relatively heavy protecting tube or box of refractory material, since the furnace is held for long periods at approximately the same temperature, and therefore the temperature lag through the protecting refractory covering is not serious. This is not true in the manufacture of optical glass, for in this case temperature must not only be raised and lowered according to a predetermined schedule, but these schedules must be followed as accurately as possible in order to have some reasonable assurance of satisfactory results. It is also important, during those periods when the furnace is held at a certain temperature, to maintain this temperature constant within very narrow limits. Consequently, it is not possible to use a rugged refractory covering for the thermocouple, since the temperature lag would make it impossible to determine slight changes in temperature or to follow with sufficient accuracy a certain schedule of raising or lowering temperature.

The covering at present used to protect the thermocouple in optical-glass furnaces from the deleterious furnace gases is a thin walled porcelain tube. The usual life of these tubes in service, at temperatures ranging from 1,450 to 1,525° C. is about five days. Needless to say, a tube having a longer life would not only be of advantage to the manufacturer of optical glass, but it would also be of value to the manufacturer of commercial glass since it would enable him to study temperature conditions in his kilns with greater accuracy.

Examination by means of the petrographic microscope has shown the cause for the corrosion and ultimate failure of the porcelain tubes when exposed to the glass furnace atmospheres. It has been found that the sodium in the furnace gases (present either as the element or the oxide) rapidly attacks the porcelain. Furthermore, the porcelain itself has been broken down from a vitreous aluminum silicate ($Al_2O_3.2SiO_2$) to a material known as mullite ($3Al_2O_3.2SiO_2$) and free silica. The reaction between the sodium from the atmosphere and the free silica presumably results in the

formation of sodium silicate, which further reacts with the mullite, forming a sodium aluminum silicate which is liquid at the furnace temperatures. The excess alumina crystallizes out as corundum.

As a result of these considerations it is believed that tubes of greater life can be produced by using a body of higher alumina content and firing it to a sufficiently high initial temperature so that practically the entire structure will be composed of mullite. This will not only present the formation of the free silica at furnace temperatures, but will also presumably offer greater resistance to the attack of the sodium.

PREVENTION OF DETERIORATION OF VULCANIZED RUBBER

It has been known for some time that deterioration of vulcanized rubber by oxidation can be delayed by the use of substances which are themselves easily oxidized and which act as anticatalysts of oxidation. Recently two of the largest rubber companies simultaneously patented almost identical antioxidants. A sample of the material received by the bureau from one of the companies has been employed in rubber compounds which were then subjected to an accelerated aging test. The bureau's results substantiate the claim that the durability of rubber with respect to the effects of light and heat can be increased about 600 per cent.

PUBLICATIONS OF THE BUREAU OF STANDARDS ISSUED DURING DECEMBER

Technologic Papers

T299. Dielectric constant, power factor, and resistivity of rubber and gutta-percha, H. L. Curtis and A. T. McPherson. Price, 20 cents.

Circulars

C1 (2d ed.). National Bureau of Standards, its functions and activities. Price, 50 cents.

C154 (supplement). Abridged volume correction table for petroleum oils. Price, 5 cents.

Simplified Practice Recommendations

R34. Elimination of waste, warehouse forms. Price, 10 cents.

Special Publications

BH8. Recommended practice for arrangement of building codes. Price, 10 cents.

OUTSIDE PUBLICATIONS

Spectral centroid relations for artificial daylight filters, K. S. Gibson, Journal of Optical Society of America and Review of Scientific Instruments, Vol. II, No. 5, p. 473, Nov., 1925.

Fine structure of spectrum lines, Arthur E. Ruark and Roy L. Chenault, Philosophical Magazine, Vol. 50, p. 937, 1925.

Phosphor bronze helical springs from the standpoint of precision instruments, W. G. Brombacher, Journal Optical Society of America and Review of Scientific Instruments, Vol. II, No. 5, p. 519, November, 1925.

Aviation Engine Performance, S. W. Sparrow, Journal of the Franklin Institute, p. 711, December, 1925.

Ratio of specific heats and the Joule-Thomson effect for ammonia, C. S. Cragoe, Refrigerating Engineering, Vol. 12, p. 131, November, 1925.

Method and apparatus for making pyrometric and other measurements, U. S. Letters Patent No. 1565093, by T. R. Harrison and Paul D. Foote.

Hydrated lime for bleach manufacture, D. F. Richardson, W. E. Emley, and J. M. Porter, Chemical and Metallurgical Engineering, Vol. 32, No. 18, p. 936, December, 1925.

Experiments with Ni. Ta,–Co and Mo in highspeed steels, H. J. French and T. G. Digges, Transactions, American Society for Steel Treating, Vol. 8, p. 681, Dec., 1925.

Effects of composition on the properties of sheet steel enamels, H. G. Wolfram, W. N. Harrison, Journal American Ceramic Society, Vol. 8, No. 11, November, 1925.

Just what constitutes a good variable condenser, E. L. Hall, Radio Age, December, 1925.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 192